0.87X vibration revisited

As stated previously, the use of only one proximity probe at each measurement plane precludes the use of full spectrum, shaft orbits, and shaft centerline position information. The precession of the shaft orbit cannot be determined. This severely limits the diagnosis of the root cause of the problem. If the orbit precession and shape is *assumed* to be *forward* and *circular*, the following explanation is offered for the observed behavior of the rotor.

The Bode plot shown in Figure 2 indicates that the pump has a balance resonance frequency occurring at 3790 rpm. This is unusual in that most pumps, due to the hydraulic stiffening influence of the seals, typically have their balance resonance frequency above operating speed. The system stiffness of a pump is determined by the rotor geometry, seals, and bearings. If the stiffness properties of any of the elements is degraded or weakened, the resonance frequency will be lowered. It was noted by inspection that the rotating balance disk had a longitudinal crack which caused excessive leakage of the pump water to the balancing chamber. This also has the effect of lowering the stiffness of the system.

During the pump loading cycle, a subsynchronous vibration occurred at 0.87X. The pump speed at which this occurred was 4370 rpm. The source of the subsynchronous vibration is the excitation of the resonance frequency ($4370 \times 0.87 = 3801$ cpm). As the pump speed was increased from 4370 to above 5000 rpm, the subsynchronous vibration remained at 0.87X. As the pump is loaded, additional stiffening occurs from internal seals and wear rings. This increases the resonance frequency and maintains the excitation at 0.87X.

Upon completing repairs to the pump, the pump was restarted on September 16, 1996. The Bode plot shown in Figure 7 indicates satisfactory operational vibration levels. It further indicates the absence of a balance resonance at 3790 rpm.